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Possible studies on generalized parton distributions and gravitational form factors

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The structure functions F_1, F_2, and F_3 of the nucleon were measured by neutrino deep inelastic inelastic scattering. These structure functions are expressed by collinear parton distribution functions, which indicate longitudinal momentum distributions of partons. In recent years, 3 dimensional (3D) structure functions have been investigated extensively for clarifying the transverse structure of the nucleon in addition to the longitudinal distributions and for understanding the origin of the nucleon spin including the partonic orbital-angular-momentum (OAM) contribution. The OAM contribution should be determined by generalized parton distributions (GPDs), which are measured mainly by deeply virtual Compton scattering and meson productions at lepton accelerator facilities (1). There are also possibilities of measuring the GPDs at hadron facilities by using high-energy exclusive reactions (2).

There is another important purpose to investigate the GPDs and the timelike GPDs (or generalized distribution amplitudes) for determining gravitational form factors to find the origin of hadron masses and their internal pressures in terms of quark and gluon degrees of freedom as studied in Ref. (3). Because the LBNF can supply neutrino beam in the energy region of 10 GeV, it is possible to measure the GPDs, for example, by the pion-production reaction $\nu_\mu + N \rightarrow \mu + \pi + N'$ \(4,5,6) in figure 1. In general, neutrino reactions are sensitive to the quark flavor, so that their measurements are complementary to the current JLab and COMPASS measurements on the GPDs and also to the future EIC project (7). Combining both neutrino and charged-lepton measurements, we could determine the flavor dependence of the quark GPDs and the gluon GPD.

1 https://research.kek.jp/people/kumanos/tmpnufact2021/nu-gpd-2.eps

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Working group

WG2

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